PB-218 290

# WATER RESOURCES STUDY, BUFFALO RIVER BASIN, ARKANSAS. STUDY OF POTENTIAL NEEDS AND VALUE OF WATER STORAGE FOR MUNICIPAL, INDUSTRIAL AND QUALITY CONTROL PURPOSES

Public Health Service
Dallas, Texas

June 1964

DISTRIBUTED BY:

NTIS

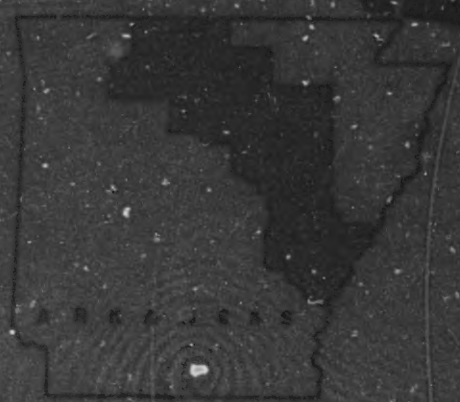
National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 218 290

# U.S. RESOURCES STUDY
# BUFFALO RIVER BASIN
# ARKANSAS

Study of Potential Need and Value of Water Storage for Municipal, Industrial, and Quality Control Purposes

RECEIVED
LIBRARY
NOV 19 1969




Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

TABLE OF CONTENTS


| | Page |
|---|---|
| LIST OF TABLES | iii |
| LIST OF FIGURES | iv |
| I. INTRODUCTION | |
| Authority | I-1 |
| Purpose and Scope | I-1 |
| Acknowledgments | I-1 |
| II. SUMMARY AND CONCLUSIONS | |
| Summary | II-1 |
| Conclusions | II-1 |
| III. DESCRIPTION OF PROJECT AREA | III-1 |
| IV. WATER RESOURCES IN THE STUDY AREA | |
| General | IV-1 |
| Existing Reservoirs | IV-1 |
| Streamflow Availability | IV-2 |
| Quality | IV-2 |
| V. ECONOMY OF THE STUDY AREA | |
| Past and Present | V-1 |
| Future | V-3 |
| VI. WATER REQUIREMENTS | |
| Municipal | VI-1 |
| Industrial | VI-1 |
| Quality Control | VI-2 |

TABLE OF CONTENTS (Continued)


| | | Page |
|---|---|---|
| VII. | PLANS FOR MEETING FUTURE WATER REQUIREMENTS . . . | VII-1 |
| VIII. | BIBLIOGRAPHY. . . . . | VIII-1 |
| IX. | APPENDIX | |
| | A. HYDROLOGY | |
| | General . . . . . | A-1 |
| | Method of Analysis. . . . . | A-1 |

# LIST OF TABLES


| | | | Page |
|---|---|---|---|
| Table | IV-1. | Pertinent Data - Existing Reservoirs In Or Adjacent to the Study Area. . . . . | IV-1 |
| | IV-2. | Chemical Quality of the Buffalo and White Rivers, Arkansas. . . . . | IV-4 |
| | V-1. | Study Area Employment and Labor Force 1950 and 1960 . . . . . | V-1 |
| | V-2. | Agricultural Statistics of the Study Area, 1944-1959 . . . . . | V-2 |
| | V-3. | Value of Mineral Production in the Study Area, 1953-1961 . . . . . | V-2 |
| | V-4. | Study Area Historic Population 1920-1960 - Urban, Rural, and Total . . . . . | V-3 |
| | V-5. | Study Area Employment and Labor Force Projections - 1960-2020 . . . . . | V-4 |
| | V-6. | Projected Population for the Study Area - Urban, Rural, Total - 1960, 1980, 2000, 2020 . . . . . | V-5 |

# LIST OF FIGURES


| | | Following Page |
|---|---|---|
| Figure III-1. | Location Map. . . . . | VII-1 |
| IV-1. | Flow Frequency Analysis, White River at Clarendon, Arkansas. . . . . | IV-2 |
| IV-2. | Relation Between Severity and Period Over Which Flow is Averaged. White River at Clarendon, Arkansas. . . . . | IV-2 |
| A-1. | Flow Frequency Analysis, White River at Newport, Arkansas. . . . . | A-1 |
| A-2. | Relation Between Severity and Period Over Which Flow is Averaged, White River at Newport, Arkansas. . . . . | A-1 |
| A-3 | Flow Frequency Analysis, Buffalo River Near Rush, Arkansas . . . . . | A-1 |
| A-4. | Relation Between Severity and Period Over Which Flow is Averaged, Buffalo River Near Rush, Arkansas . . . . . | A-1 |
| A-5. | Flow Frequency Analysis, Buffalo River Near St. Joe, Arkansas. . . . . | A-1 |
| A-6. | Relation Between Severity and Period Over Which Flow is Averaged, Buffalo River Near St. Joe, Arkansas. . . . . | A-1 |

# I. INTRODUCTION

## Authority

In a letter dated May 29, 1963, the U.S. Army Engineer District, Little Rock, requested the Public Health Service to make an investigation on ". . . the need for and value of storage in the Buffalo River, for municipal and industrial water supply and water quality control."

This study has been made in accordance with (1) the Water Supply Act of 1958 (Public Law 85-500, Title III) and a Memorandum of Agreement between the Department of the Army and the Department of Health, Education, and Welfare, dated November 4, 1958; and (2) the Federal Water Pollution Control Act (Public Law 84-660) as amended by Public Law 87-88.

## Purpose and Scope

The purpose of this study was to determine water requirements to the year 2020 for municipal, industrial, and water quality control purposes in a 17-county area of north-central Arkansas, encompassing the Buffalo and contiguous river basins. The conclusions reached in this report evolved from projected economic developments and anticipated needs for water supply and stream quality preservation.

## Acknowledgments

Appreciation is expressed to the following organizations who gave counsel and technical advice during the preparation of this report:

U.S. Army Engineer District, Little Rock, Arkansas
U.S. Geological Survey, Little Rock, Arkansas
U.S. Department of Agriculture, Little Rock, Arkansas
Bureau of Mines, Bartlesville, Oklahoma
Arkansas State Board of Health, Little Rock, Arkansas
Arkansas Water Pollution Control Commission, Little Rock, Arkansas
Arkansas State Geology Department, Little Rock, Arkansas
Arkansas Industrial Development Commission, Little Rock, Arkansas
Industrial Research and Extension Center, University of Arkansas, Little Rock, Arkansas
Arkansas State Planning Commission, Little Rock, Arkansas
Business and Public Administration Research Center, University of Missouri, Columbia, Missouri

# II. SUMMARY AND CONCLUSIONS

## Summary

1. The study area consists of 17 counties in north-central Arkansas encompassing the Buffalo River and extending downstream along the White River to its junction with the Mississippi River.

2. Agriculture is the leading employment and income-producing industry in the study area. The majority of the agricultural income in the study area results from the sale of cotton, soybeans, and rice.

3. The 17-county study area has only 9 cities with a 1960 population of 2,500 or greater. The largest of these had a 1960 population of 11,500. The total 1960 population of the study area was 260,318.

4. The 1958 urban water demand was 6.0 million gallons daily (mgd) with six taking their water from ground sources, two from streams, and one from springs. The average per capita use of all nine cities was 89 gallons per day in 1958.

5. Both ground and surface waters are abundant and of excellent quality, suitable for municipal and industrial uses.

## Conclusions

1. The urban population is expected to reach 335,000 by the year 2020 and the total population is expected to be 403,000 for that year.

2. Agriculture is expected to continue to increase its output with much of this increased production resulting from highly specialized farm programs. Mining will increase in the production of materials used for construction or inputs for local industries. Other employment groups are expected to continue in the same activities reflected by the past with the exception of services which could increase.

3. The natural ground and surface water resources of the study area far exceed the currently expected requirements based on projections of municipal and industrial growth. On this basis, and on the information presently available, there is no foreseeable need or benefit for storage in the Buffalo River

basin to meet future municipal and industrial water requirements of the study area.

4. The abundance of high quality water is more than adequate to assimilate treated wastes many times in excess of that from projected municipal and industrial concerns. Since waste discharges from future development are not expected to markedly deteriorate water quality, there is no expected need or benefit from storage for water quality control in the study area.

# III. DESCRIPTION OF PROJECT AREA

The study area consists of 17 counties in north-central Arkansas encompassing the Buffalo River and extending downstream along the White River to its junction with the Mississippi River. This area is shown in figure III-1 following page VII-1. The study area was selected to represent that area which might reasonably be affected economically by water resource development in the Buffalo River basin. Recognition was also given to the significance of the study area as a part of a larger area to be considered in a forthcoming study of the White River basin.

The northern part of the area is characterized by the mountains and highlands of the Ozark Plateau. Streams in this area have cut deeply into cavernous limestone formations giving rise to high spring flows in some areas which are sustained even during periods of low rainfall.

Downstream from Batesville, the White River runs through the alluvial flood plain of the Mississippi River where the channel widens and the banks become more stable. It has been necessary to levee a considerable portion of the valley downstream from Batesville.

The study area has a mean annual rainfall of about 50 inches and a mean annual temperature near $60^{\circ}$ F. Annual freeze-free days vary from 220 in the north to 270 in the south.

Ground water is in abundance in Boone, Marion, and Baxter Counties and in the flood plain of the Mississippi River below Batesville. 1/

# IV. WATER RESOURCES IN THE STUDY AREA

## General

The study area is blessed with copious amounts of high quality surface and ground water. Several basin characteristics are responsible for the favorable surface water supply, including: a high annual rainfall; an area underlain with high flow-yielding cavernous limestone aquifers; basins free from sources of natural chemical pollutants; and a favorable ratio of municipal and industrial waste to prevailing streamflow.

## Existing Reservoirs

As shown in figure III-1, there are six major reservoirs within, or adjacent to, the 17-county study area. Four of these reservoirs are on the White River and two are on tributaries. Characteristics of these reservoirs are shown in table IV-1.

Table IV-1

Pertinent Data - Existing Reservoirs In Or Adjacent to the Study Area

| Reservoir | Storage (1,000 acre-feet) Total | Flood | Power | Dead |
|---|---|---|---|---|
| Beaver | 1,952 | 300 | 925* | 727* |
| Bull Shoals | 5,408 | 2,360 | 1,003 | 2,045 |
| Greers Ferry | 2,844 | 934 | 716 | 1,194 |
| Norfork | 1,983 | 732 | 448 | 803 |
| Table Rock | 3,462 | 760 | 1,182 | 1,520 |
| Taneycomo | 24 | -- | 24 | -- |
| TOTAL | 15,673 | 5,086 | 4,298 | 6,289 |

* Municipal and industrial supply is included in total power and dead storage

Source: University of Arkansas 2/

As shown by table IV-1, large volumes of water can be stored in the six reservoirs and of the total storage, 37 percent is classified as dead storage.

Dead storage is that amount held below the normal operating elevation of the reservoir and is not released under normal operating conditions. However, waters held in such storage may be made available, if necessary, and if such use does not interfere with other reservoir purposes.

Reproduced from best available copy.

## Streamflow Availability

Streams and rivers in the White River basin have high flows which, in some instances, are sustained during periods of low rainfall by contributions from cavernous limestone formations located in northern parts of the basin.

A graphical picture of the availability of water in the White River at Clarendon, Arkansas, is shown in figure IV-1 and figure IV-2 and is based on work by Velz and Gumbel. [3-5] This information results from data supplied by the Geological Survey and presents a statistical summation of flows which can be expected during various drought periods over the year and the return period or recurrence interval corresponding to these flows.

Figure IV-1 was developed by using the average flow during various drought periods of each year and expressing them both by probability of occurrence and the recurrence interval. For example, the low-seven consecutive days that are expected to occur once in ten years at Clarendon, Arkansas, on the White River will have a mean flow of about 3,600 cubic feet per second (cfs).

Figure IV-2 is an adaptation of figure IV-1. It relates the severity of drought flows to the probability of occurrence ranging from the most probable to that which recurs once in 20 years. For example, the most probable 30-day low flow at Clarendon is 7,000 cfs while the 30-day low flow expected to recur once in 20 years is about 3,500 cfs.

Four points were selected for presentation in this way. The White River at Newport, Arkansas, and two points on the Buffalo River are shown in figures A-1 through A-6 located in Appendix A.

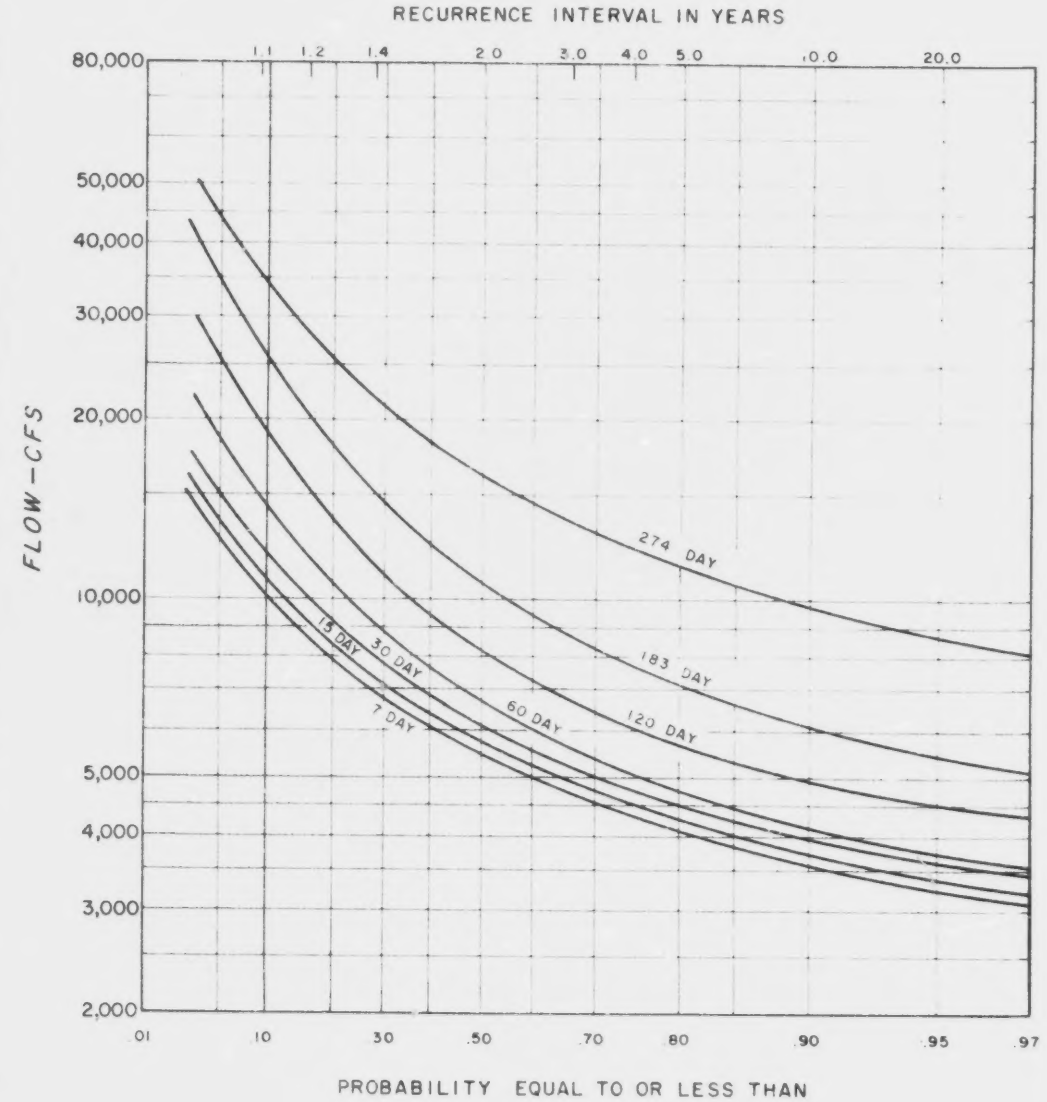
## Ground Water Availability

Ground water is one of Arkansas most important assets and this is especially true of the Buffalo and White River basins. It makes possible many public water supply systems for small towns that do not have economical access to surface sources. It readily supplies domestic and stock water in rural areas beyond public water mains. Reported yields of wells within the study area generally range 50 to 500 gallons per minute (gpm) with some wells yielding as high as 2,000 gpm. [6]

## Quality

### Buffalo-White Rivers

The quality of waters in the Buffalo and White Rivers is exceptional. All chemical constituents in these waters are well within the Public Health Service drinking water standards.



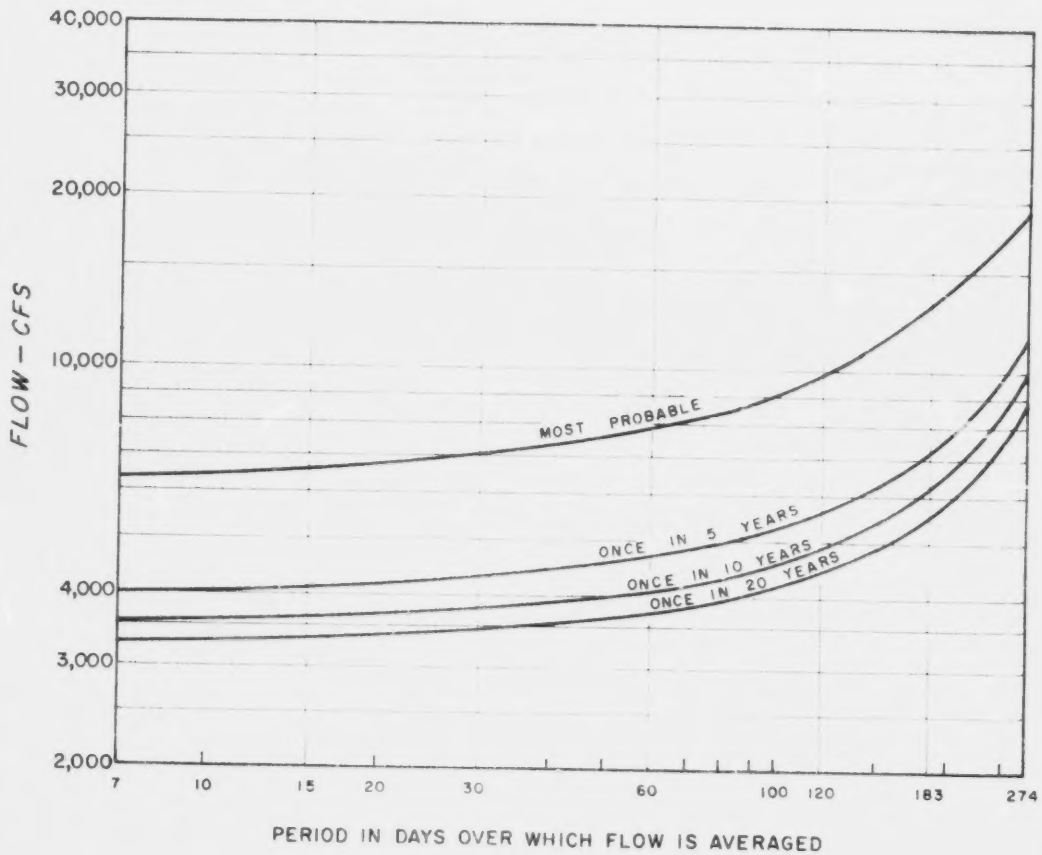

WATER RESOURCES STUDY
BUFFALO RIVER-ARKANSAS

## FLOW FREQUENCY ANALYSIS

WHITE RIVER AT CLARENDON, ARKANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE IV-1




WATER RESOURCES STUDY
BUFFALO RIVER–ARKANSAS

RELATION BETWEEN SEVERITY AND PERIOD OVER WHICH FLOW IS AVERAGED
WHITE RIVER AT CLARENDON, ARKANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE IV – 2

Table IV-2 depicts the chemical quality of the Buffalo River at St. Joe and the White River at Newport and Clarendon. Especially significant is the chloride analysis where all three sample stations report an average of less than 6 milligrams per liter (mg/l).

Dissolved solids range around 150 mg/l which is a fraction of the 500 mg/l Public Health Service drinking water standard for dissolved solids. Sulfate and nitrate content of the waters are also quite low.

Waters of the above quality, in addition to being an ideal source for municipal and industrial use, have the potential to assimilate appreciable waste loads.

## Ground Water

Ground water quality data for the Buffalo River and White River basin areas are scarce but data available for the ground water supplies of Newport, Clarendon, and De Valls Bluff are shown on table IV-2. These ground water analyses are comparable to the surface water analyses of the same areas.

Table IV-2

Chemical Quality of the Buffalo and White Rivers, Arkansas
(mg/l)

| River | Samples | Dissolved Solids* | | | Chlorides | | | Sulfates | | | Nitrates | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Max. | Min. | Avg. | Max. | Min. | Avg. | Max. | Min. | Avg. | Max. | Min. | Avg. |
| Buffalo River at St. Joe, Ark. | 57 | 219 | 80 | 127 | 5.8 | 1.5 | 3.4 | 16 | 3.2 | 5.6 | 5.7 | 0.1 | 2.0 |
| White River at Newport, Ark. | 111 | 388 | 98 | 165 | 123 | 0.5 | 5.0 | 14 | 2.0 | 6.2 | 5.1 | 0.3 | 2.2 |
| White River at Clarendon, Ark. | 119 | 282 | 38 | 145 | 58 | 2.0 | 5.8 | 23 | 1.0 | 4.5 | 7.8 | 0.1 | 1.8 |

Ground Water

| City | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Newport, Ark. | 3 | 194 | 152 | 171 | 10 | 7 | 8.5 | 26.5 | 19 | 23 | --- | --- | --- |
| Clarendon, Ark. | 2 | 405 | 384 | 395 | 82 | 52.5 | 68 | 0 | 0 | 0 | --- | --- | --- |
| De Valls Bluff, Ark. | 1 | --- | --- | 215 | --- | --- | 7 | --- | --- | 5 | --- | --- | --- |

* Dissolved solids refers to residue after evaporation at 180° F.

Sources: Arkansas State Board of Health [7]
Geological Survey [8]

# V. ECONOMY OF THE STUDY AREA

## Past and Present

Determination of future water requirements for the study area (described in Chapter III and detailed in figure III-1) involves appraisal of the area's population and industrial growth potential.

In 1960 the study area per capita income was $1,262 (1961 dollars) compared to $1,350 for the State of Arkansas and $2,237 for the U.S. 9/ Total employment in the study area was 78,711.

Table V-1 shows employment patterns of the 17-county study area. The most significant change in employment was a decrease in agriculture accompanied by an increase in manufacturing and other employed. Large agricultural employment losses in all 17 counties amounted to a total loss of almost 23,000 workers from this segment of the economy. Although manufacturing and other employed experienced slight increases in employment, the loss from agriculture resulted in an overall employment decline of over 15,600 workers.

Table V-1

Study Area Employment and Labor Force
1950 and 1960

| Industry | 1950 Number of Employees | 1950 % of Total Labor Force | 1960 Number of Employees | 1960 % of Total Labor Force |
|---|---|---|---|---|
| Agriculture* | 45,529 | 45.7 | 22,622 | 27.0 |
| Mining | 399 | .4 | 287 | .3 |
| Manufacturing | 10,206 | 10.2 | 12,984 | 15.5 |
| All Other Employed | 39,037 | 39.2 | 42,818 | 50.9 |
| Unemployed | 4,469 | 4.5 | 5,310 | 6.3 |
| Total Labor Force | 99,640 | 100.0 | 84,021 | 100.0 |

*Includes Forestry and Fisheries
Source: Bureau of the Census 10/

Agriculture is the leading employment and income-producing industry in the study area. An employment loss of over 50 percent from 1950 to 1960 was accompanied by a 98 percent increase in the value of farm products sold between 1949 and 1959. This information indicates a higher productivity and advanced technological innovations such as new crop varieties, better management and increased use of fertilizers. Table V-2 indicates a consolidation of harvested lands, in that the number of farms decreased about 46 percent from 1944 to 1959, while the number of harvested acres remained essentially unchanged. The majority of the agricultural income in the study area resulted from the sale of cotton, soybeans, and rice in counties adjacent to the White River below Batesville. In 1959, the sale of

these crops accounted for over 70 percent of the total value of farm products sold in the study area. 11/

Table V-2

Agricultural Statistics of the Study Area
1944-1959

| Year | No. of Farms | Acres of Cropland Harvested | Value of All Farm Products Sold (1,000's of 1960 dollars) |
|---|---|---|---|
| 1944 | 38,184 | 1,330,302 | 69,146 |
| 1949 | 36,687 | 1,324,425 | 69,276 |
| 1954 | 29,620 | 1,299,763 | 105,549 |
| 1959 | 20,736 | 1,302,929 | 128,605 |

Source: Bureau of the Census 11/

The 1961 mineral production was valued at $2,752,000 as shown in table V-3. Principal minerals produced are lime, stone, sand, and gravel. Study area mineral production has declined in value since 1959. Most of this decline was a result of the termination of the government's manganese stockpiling program in 1959. Since that time, Arkansas-mined manganese under present market prices could not compete with imports of foreign ore that are extracted more cheaply. 12/

Table V-3

Value of Mineral Production in the Study Area
1953-1961
(1,000's of 1960 dollars)

| 1953 | 1954 | 1955 | 1956 | 1957 | 1958 | 1959 | 1960 | 1961 |
|---|---|---|---|---|---|---|---|---|
| 2,511 | 3,484 | 3,961 | 4,409 | 3,998 | 3,849 | 4,127 | 2,933 | 2,752 |

Source: Bureau of Mines 13/

Manufacturing employment increased about 13 percent between 1950 and 1960, which was considerable lower than the 32 percent increase experienced by the entire State of Arkansas. Manufacturing activities are widely diversified but center mainly around furniture and wood products, apparel, leather products, and food and kindred processing.

Although many of the industries located in the study area are considered heavy water-using industries, (poultry processing, can-

ning, meat packing, etc.,) most of these are small and exert minor influence on total water requirements of the study area.

Over 75 percent of the 1960 study area population was classified rural, compared to 57 percent for Arkansas and 30 percent for the Nation. As shown in table V-4, study area urban population has increased each census since 1930. However, the loss of nearly 85,000 rural dwellers since 1940 has resulted in a net population loss of over 63,000. The more than 64,000 urban dwellers are spread among 9 cities in the study area. The largest of these cities was Helena in Phillips County with a 1960 population of 11,500.

Table V-4

Study Area Historic Population 1920-1960 - Urban, Rural, and Total

| Year | Urban | Rural | Total |
|---|---|---|---|
| 1920 | 39,695 | 282,207 | 321,902 |
| 1930 | 36,822 | 274,270 | 311,092 |
| 1940 | 42,327 | 281,413 | 323,740 |
| 1950 | 58,416 | 245,658 | 304,074 |
| 1960 | 64,267 | 196,051 | 260,318 |

Source: Bureau of Census 14/

## Future

Future growth of the study area will be determined by the conditions of the national economy and the area's ability to compete with other areas in the production of goods and services by development of its natural and human resources. The Nation's population is expected to reach 502 million by 2020 with total employment of 197 million and per capita income rising to over $7,000. 15/ According to the Corps of Engineers 9/, study area population will reach 403,000 with employment of 145,000 and per capita income of $6,250 by 2020. Projections of employment appear in table V-5 along with the 1960 employment patterns.

Table V-5

Study Area Employment and Labor Force
Projections - 1960 - 2020

| | 1960 | | 2020 | |
|---|---|---|---|---|
| | No. of Employees | % of Total Labor Force | No. of Employees | % of Total Labor Force |
| Agriculture* | 22,622 | 27.0 | 11,000 | 7.3 |
| Mining | 287 | .3 | 500 | .3 |
| Manufacturing | 12,984 | 15.5 | 31,000 | 20.5 |
| All Other Employed | 42,818 | 50.9 | 102,500 | 67.9 |
| Unemployed | 5,310 | 6.3 | 6,000 | 4.0 |
| Total Labor Force | 84,021 | 100.0 | 151,000 | 100.0 |

*Includes Forestry and Fisheries

Source: Bureau of the Census 10/

Study area agriculture is expected to continue to increase its output in response to increasing regional and national demands for its products. Much of this increased production is expected to result from highly specialized farming programs such as broiler and vegetable production. These types of programs will require very intensive management, as well as available water which is plentiful in this area for supplemental irrigation.

As shown in table V-5, mining employment in the study area is expected to reach 500 by 2020 which is nearly double the 1960 mining employment. Most of this increased mining activity will be experienced in the production of materials used in construction or inputs for local industries. These products will likely be used in or adjacent to the study area. Production of manganese ores is not likely to resume until more economic methods of mining the low-grade ore are discovered, or the government has a need to stockpile manganese. 12/

Manufacturing employment is expected to more than double by 2020, with manufacturing accounting for more than 20 percent of the total labor force. (See table V-5.) Much of the increased manufacturing activity is expected to center around those industries presently located in the area--furniture and wood products, apparel, leather products, and food and kindred processing. According to a recent study made by the U.S. Department of Agriculture 16/ the number of poultry processing plants will increase from 8 to 14 and food processing plants will increase from 8 to 21 in the study area by the year 2000. Most of this increased processing of food and kindred products will be relatively small in scale and have a minor influence on future water requirements. The Corps of Engineers made

a study which indicated that sufficient forest resources were available in the Batesville area to support a pulp mill with a capacity of 150 tons of pulp per 24 hours, employing about 200 persons, with associated bag companies employing approximately 400 persons expected to locate near the pulp mill. 17/ This information is reflected in the employment projection, table V-5, and the water requirement chapter which follows.

In addition to those groups previously discussed, the employment group "all other employed," is expected to more than double by 2020 and account for 65 percent of the labor force. This increase is expected to result from a normal economic growth of the area and a trend toward increased recreational activities.

As previously discussed, the study area has experienced a loss of total population since 1940. This loss was a result of outmigration of rural population without sufficient urban growth to compensate for the loss. Future urban growth is expected to more than compensate for rural losses in the future. As shown in table V-6, 2020 study area population is expected to reach 403,000 with over 80 percent of the population residing in urban areas.

Table V-6

Projected Population for the Study Area - Urban, Rural, Total - 1960, 1980, 2000, 2020

| Year | Urban Population | Rural Population | Total Population* |
|---|---|---|---|
| 1960 | 64,267 | 196,051 | 260,318 |
| 1980 | 140,000 | 122,000 | 262,000 |
| 2000 | 224,000 | 82,000 | 306,000 |
| 2020 | 335,000 | 68,000 | 403,000 |

*Total population projections were made by the Corps of Engineers, Little Rock District. 9/

# VI. WATER REQUIREMENTS

## Municipal

As discussed in the previous chapter, the more than 64,000 urban dwellers in the study area reside in nine cities, the largest being Helena in Phillips County with a 1960 population of 11,500.

The 1958 water use of these nine urban areas amounted to a total of 6.0 million gallons daily (mgd), with six taking their water from ground sources, two from streams, and one from springs. The average per capita use of all nine cities was 89 gallons per day in 1958 with a range from 60 to 140 gallons per capita day. Included in these per capita demands are service industries, and in some cases, small food and poultry processing establishments.

An investigation has been made for areas adjacent to the study area in which per capita water use was correlated with mean annual rainfall. [18/] This report shows that areas similar to the study area are expected to experience a per capita water demand increase of about 40 gallons per day by the year 2020. On this basis, the per capita water demand of the study area is expected to reach about 130 gallons daily by that year, and will include the normal service industries connected with communities of this type.

As shown on table V-6, the urban population for the study area is expected to reach 335,000 by the year 2020. This segment of the population will require 43.6 mgd of municipal water supply by that year.

Assuming that the general locations of population concentration in the year 2020 will be similar to the past, about 80 percent of the urban population will be located along or near the White River from the vicinity of its confluence with the Black River (see figure III-1) to the Arkansas and Mississippi Rivers. Likewise, this would be the general location of 80 percent of the urban water demand or about 35 mgd in the year 2020. Following this same reasoning, about 60 percent of the study area's total urban population will reside along or near the White River from the vicinity of Clarendon to the Arkansas and Mississippi Rivers. Consequently, 60 percent of the urban water requirement or about 26 mgd will be needed in this area.

## Industrial

Chapter V discusses the expected growth of poultry and food processing plants in the study area as determined by the U.S. Department of Agriculture. These plants are expected to be small, and could be served by municipal water systems. The U.S. Department

of Agriculture predicts that the food processing plants will each use about 12,000 gallons of water daily over a 5-month period each year.

The Corps of Engineers indicated that a pulp mill could be placed in the vicinity of Batesville with a capacity of 150 tons per day. A plant of this size would have a water requirement of about 5.3 mgd. 2/

## Quality Control

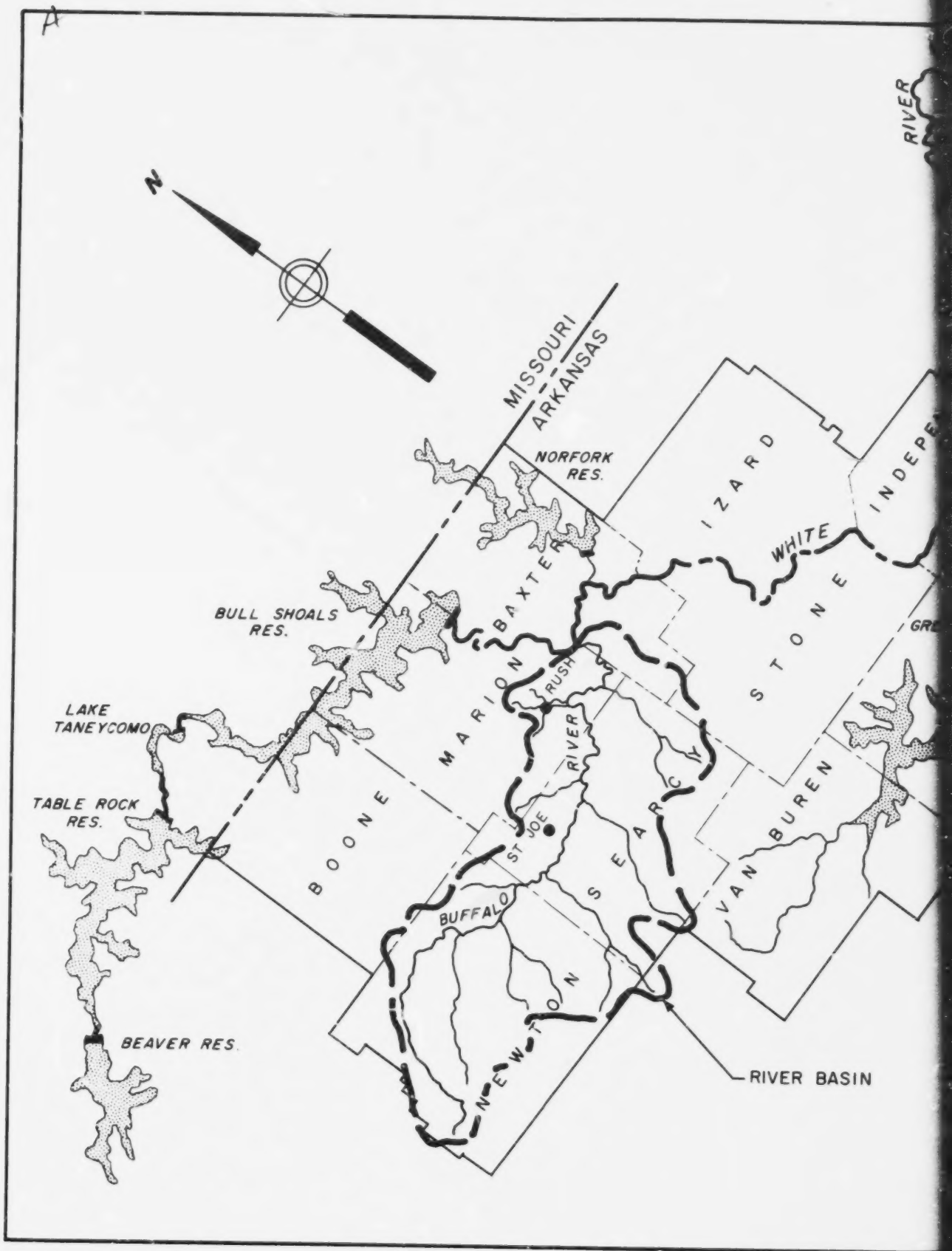
Figure A-2 in Appendix A shows that the low 7-day flow which can be expected to recur in the White River at Newport, once in 20 years, is about 2,000 mgd (3,100 cfs). Figure IV-2 shows that the low 7-day flow, with a return period of 20 years, at Clarendon on the White River is about 2,100 mgd (3,300 cfs). Since 80 percent of the total anticipated water demand will be located in the vicinity of these two points, and the basin is free from natural chemical and organic pollutants, a dilution ratio of at least 57 to 1 will exist even at this severe low flow. This is assuming that all of the water demand is returned as waste. In reality, the return flow is about 60 percent of the water demand and in this case, the dilution ratio is higher.

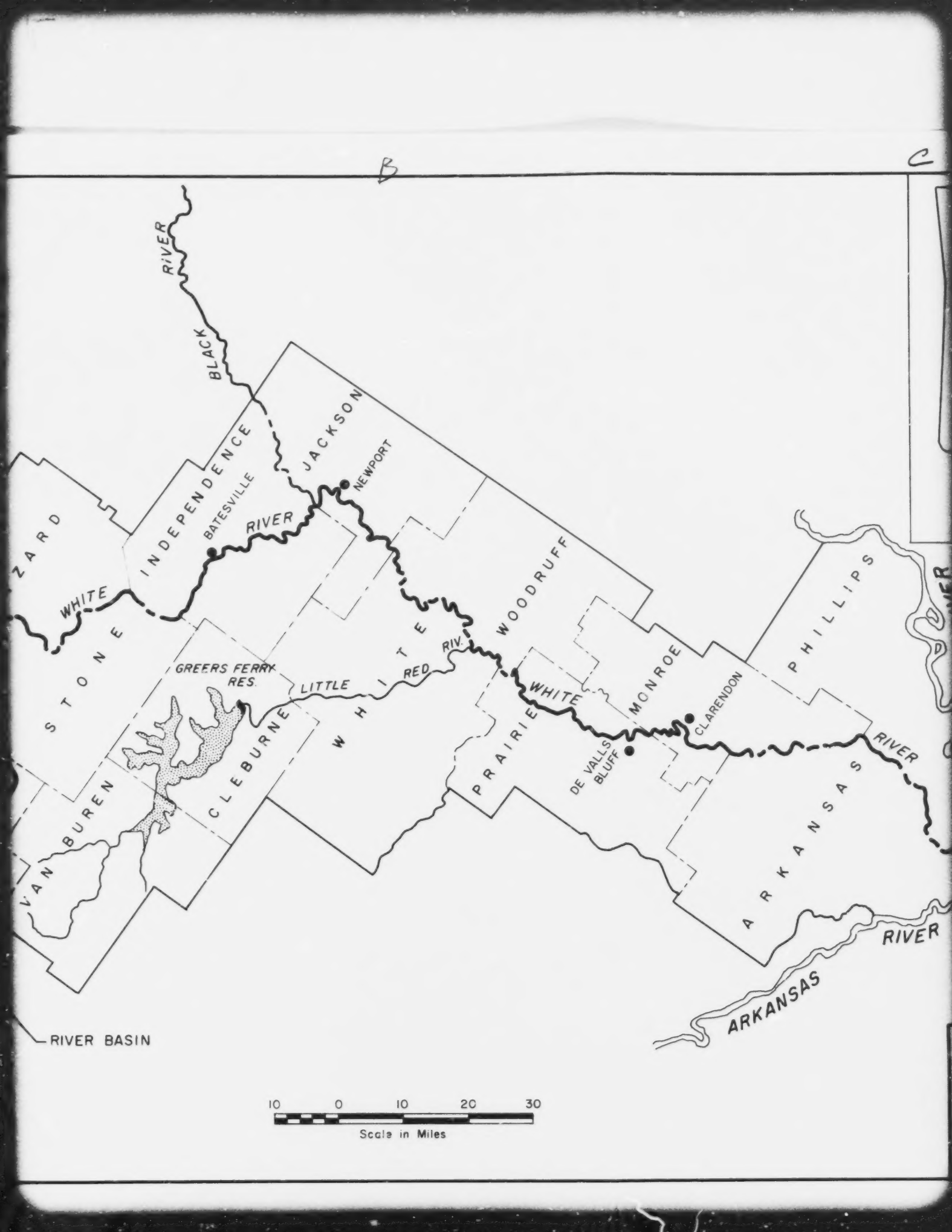
# VII. PLANS FOR MEETING FUTURE WATER REQUIREMENTS

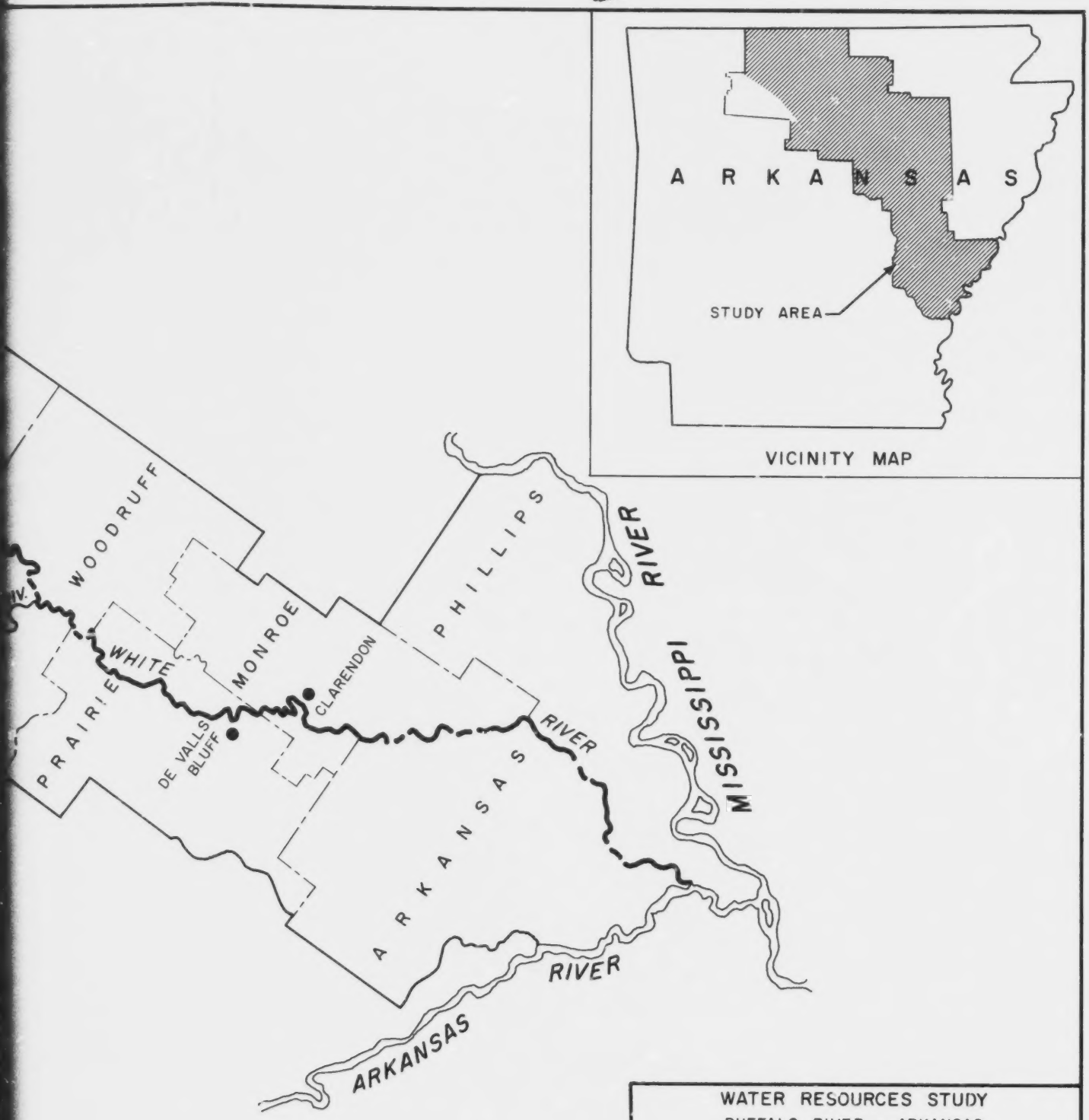
Chapter IV points out that an abundance of high quality surface and ground water exists in the study area. Figures IV-1 and IV-2 and Figures A-1 through A-6 show the extent of streamflows in the area.

In comparing the availability of waters in the study area to water needs, it can be seen that these natural ground and surface water resources far exceed the currently expected requirements based on projections of municipal and industrial growth. On this basis and on the information presently available, there is no foreseeable need, or benefit for storage in the Buffalo River basin, to meet the projected municipal and industrial water requirements of the study area.

The abundance of high quality water discussed in chapter IV is more than adequate to assimilate treated wastes many times in excess of that from projected municipal and industrial concerns. Since waste discharges from future development are not expected to markedly deteriorate water quality, there is no expected need for, or benefit from, storage for water quality control in the study area.


A
N
MISSOURI
ARKANSAS
NORFORK RES.
BULL SHOALS RES.
LAKE TANEYCOMO
TABLE ROCK RES.
BEAVER RES.
BOONE
MARION
BAXTER
IZARD
STONE
WHITE
RUSH
BUFFALO
ST JOE
SEARCY
VAN BUREN
NEWTON
RIVER BASIN


B
C
BLACK RIVER
INDEPENDENCE
JACKSON
NEWPORT
BATESVILLE
RIVER
WHITE
ZARD
STONE
GREERS FERRY RES.
LITTLE RED RIV.
WOODRUFF
PHILLIPS
MONROE
CLARENDON
DE VALLS BLUFF
PRAIRIE
WHITE
CLEBURNE
VAN BUREN
ARKANSAS RIVER
ARKANSAS RIVER
RIVER BASIN
10 0 10 20 30
Scale in Miles




WATER RESOURCES STUDY
BUFFALO RIVER — ARKANSAS

LOCATION MAP

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE III-1

# VIII. BIBLIOGRAPHY


1. Arkansas-White-Red Basins Inter-Agency Committee, Arkansas-White-Red River Basins, Part II, Sec. 9, "Water Pollution Control," 1955.

2. Wood, Noel H., Arkansas Water Resources, Arkansas, University of Arkansas, June 1959.

3. Velz, Clarence J., Drought Flow of Michigan Streams, Michigan, University of Michigan.

4. Velz, Clarence J., Water and Sewage Works, "Graphical Approach to Statistics," 99 (4) April 1952.

5. Gumbel, E. J., American Mathematical Statistics, "The Return Period of Flood Flows," 163, 1941.

6. Geological Survey, The Role of Ground Water in the National Water Situation, Washington, Government Printing Office, 1963, (Water-Supply Paper 1800).

7. Arkansas State Board of Health, Arkansas Municipal Water Supplies - Chemical Data, Arkansas, 1961.

8. Geological Survey, Quality of Surface Waters of the United States, 1953-1957, Parts 7-8, "Lower Mississippi River Basin and Western Gulf of Mexico Basins," Washington, Government Printing Office.

9. Data and projections provided by Corps of Engineers, Little Rock District, transmitted letter SWLGA-4, dated 22 October 1963.

10. Bureau of the Census, Census of Population, 1950-1960, "Characteristics of the Population," Washington, Government Printing Office.

11. Bureau of the Census, Census of Agriculture, 1944-1959, Washington, Government Printing Office.

12. Information provided by Mineral Resources office, Bureau of Mines, Bartlesville, Oklahoma.

13. Bureau of Mines, Mineral Yearbooks, 1953-1961, Vol. 3, "Area Reports," Washington, Government Printing Office.

14. Bureau of the Census, Census of Population, 1920-1960, "Number of Inhabitants," Washington, Government Printing Office.

15. Economic Task Group of the AD HOC Water Resources Council Staff, National Economic Growth Projections, 1980, 2000, and 2020, July 1963.

16. Preliminary estimates of projected growth of agricultural related industries in the White River basin trade areas and the Buffalo River sub-basin trade areas, by Resource Development Economic Division, Economic Research Service, Department of Agriculture, September 1963.

17. Letter from Corps of Engineers, Little Rock District, SWLGA-4, dated 15 October 1963.

18. Public Health Service, Water Quality Conservation, Arkansas-Red River Basins, Appendix, Vol. 3, "Benefits Evaluation," Dallas, Texas, March 1964.

# IX. APPENDIX

# APPENDIX A

# HYDROLOGY

## General

In the planning of a surface water supply to satisfy future municipal, industrial, and water quality control requirements, estimates of natural streamflows that can be expected to occur at some selected probability level must be made. In this way, the natural supply can be weighed against the anticipated demand in order to provide a rational basis for providing storage.

## Methods of Analysis

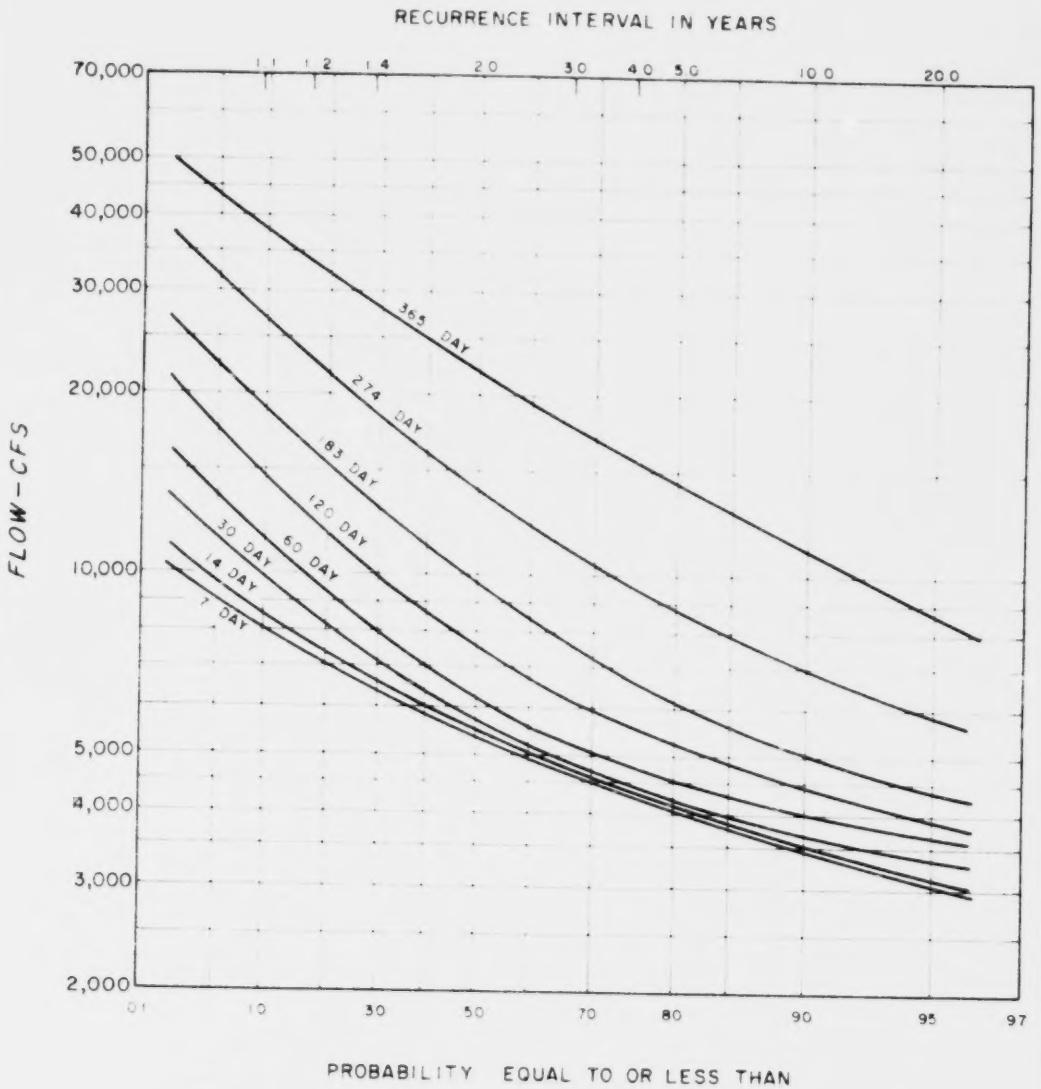
Stream discharge data were taken from records of the Geological Survey and the mean flow of various time series was determined and supplied by that organization.

Flow frequency analysis were based on the distribution of extreme values developed by Gumbel, 5/ and the results are presented according to works by Velz. 3/

Figures A-1 through A-6 are supplemental to figures IV-1 and IV-2. They deal with the White River at Newport, Arkansas, and the Buffalo River at Rush and St. Joe, Arkansas.

Figures A-1, A-3, and A-5 express the average flow during various drought periods in relation to the probability of occurrence and the return period.

Figures A-2, A-4, and A-6 relate the severity of drought flows to the probability of occurrence, ranging from the most probable to that which recurs once in 20 years.

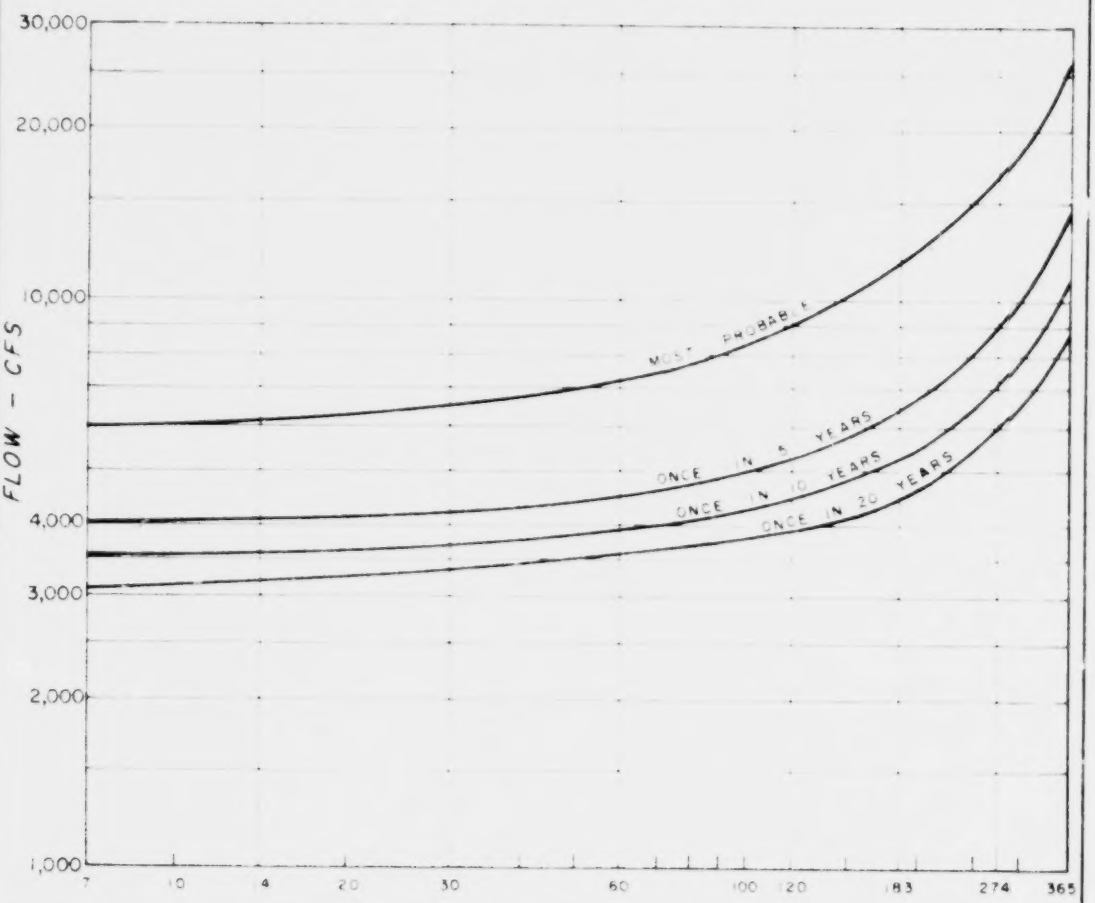



WATER RESOURCES STUDY
BUFFALO RIVER - ARKANSAS

FLOW FREQUENCY ANALYSIS
WHITE RIVER AT NEWPORT, ARKANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE A - 1

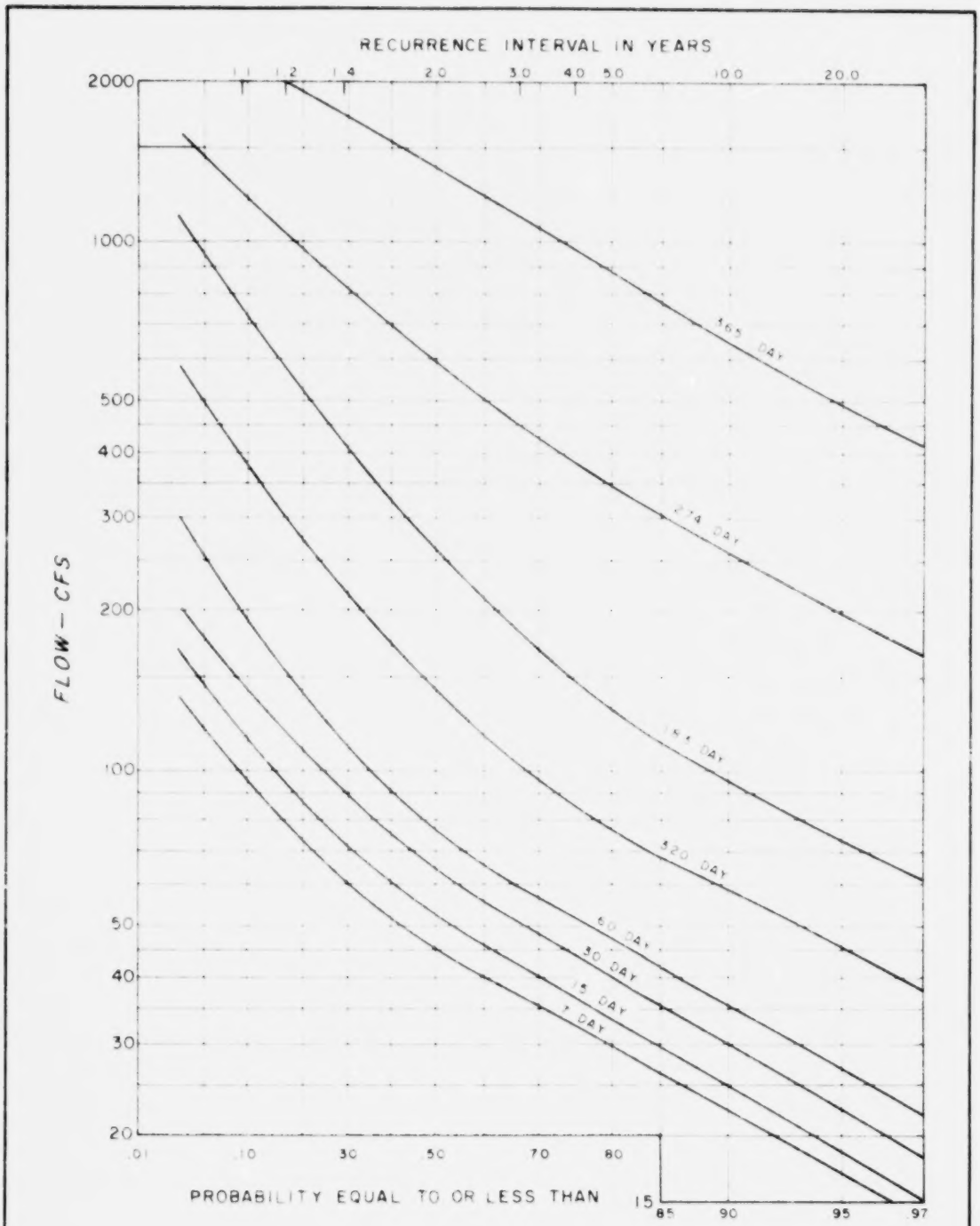



WATER RESOURCES STUDY
BUFFALO RIVER-ARKANSAS

RELATION BETWEEN SEVERITY AND PERIOD OVER WHICH FLOW IS AVERAGED
WHITE RIVER AT NEWPORT, ARKANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE A - 2



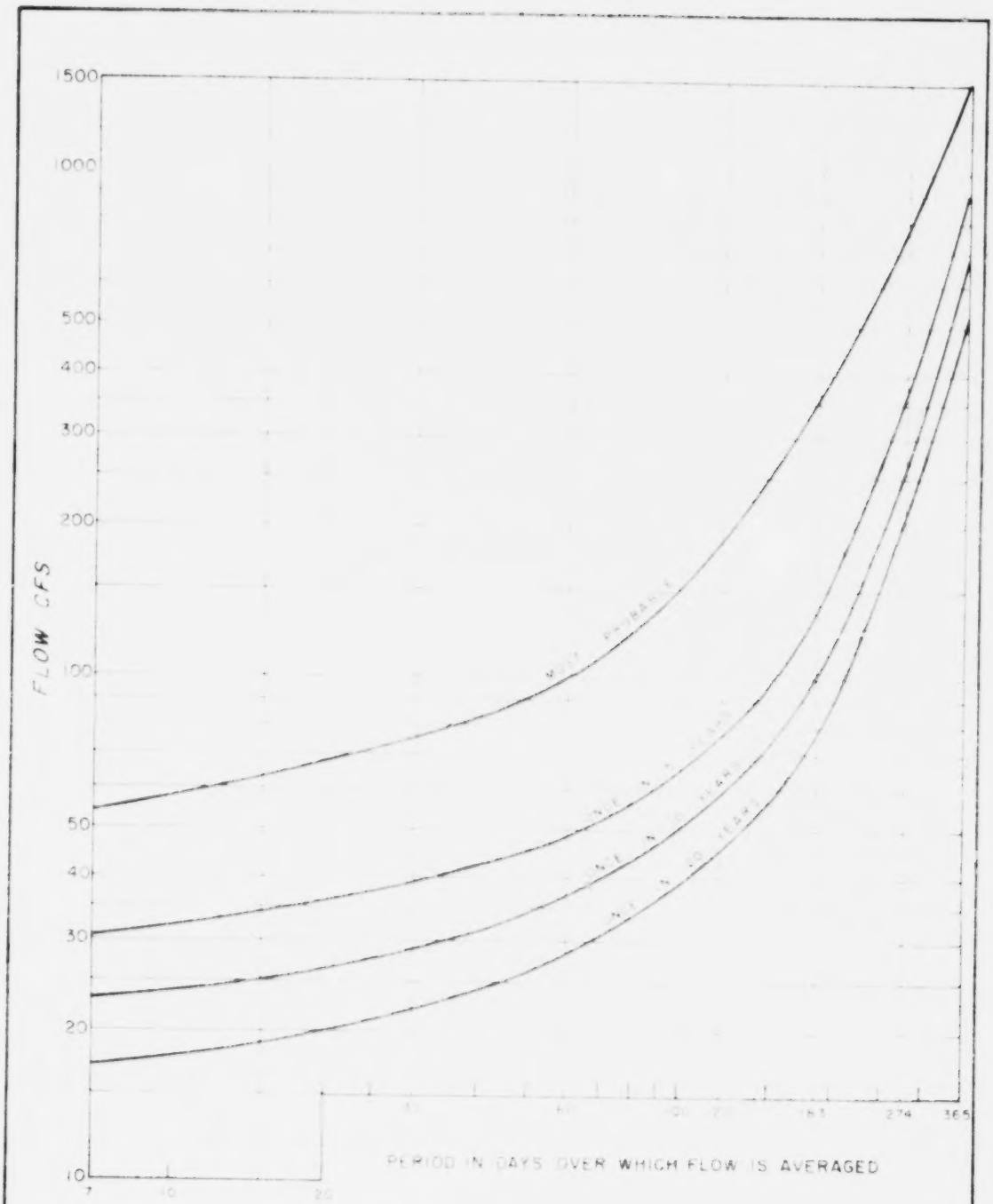

WATER RESOURCES STUDY
BUFFALO RIVER – ARKANSAS

## FLOW FREQUENCY ANALYSIS

BUFFALO RIVER NEAR RUSH, ARKANSAS

U S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE A – 3




WATER RESOURCES STUDY
BUFFALO RIVER – ARKANSAS

RELATION BETWEEN SEVERITY AND PERIOD OVER WHICH FLOW IS AVERAGED
BUFFALO RIVER NEAR RUSH, ARKANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE A – 4

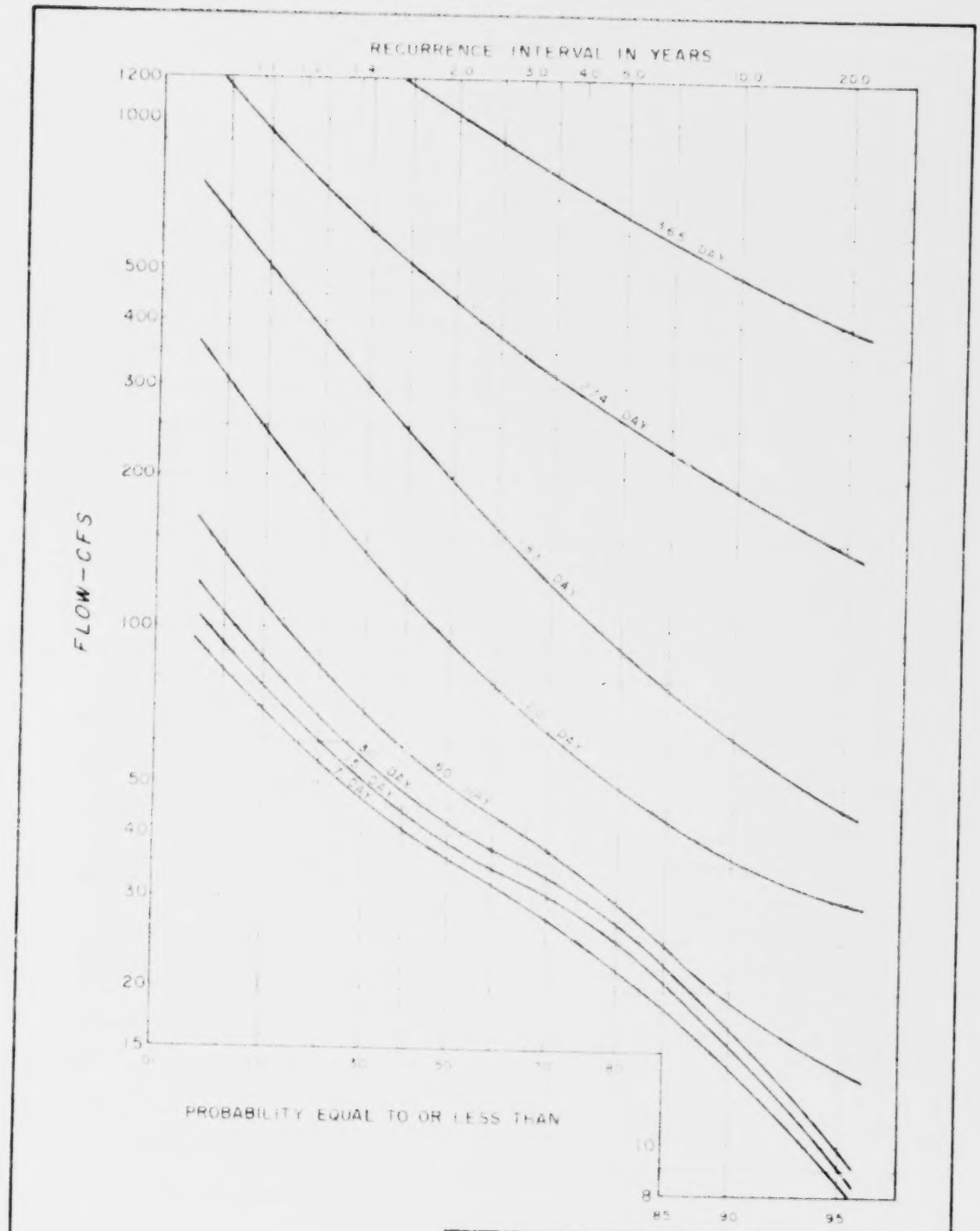
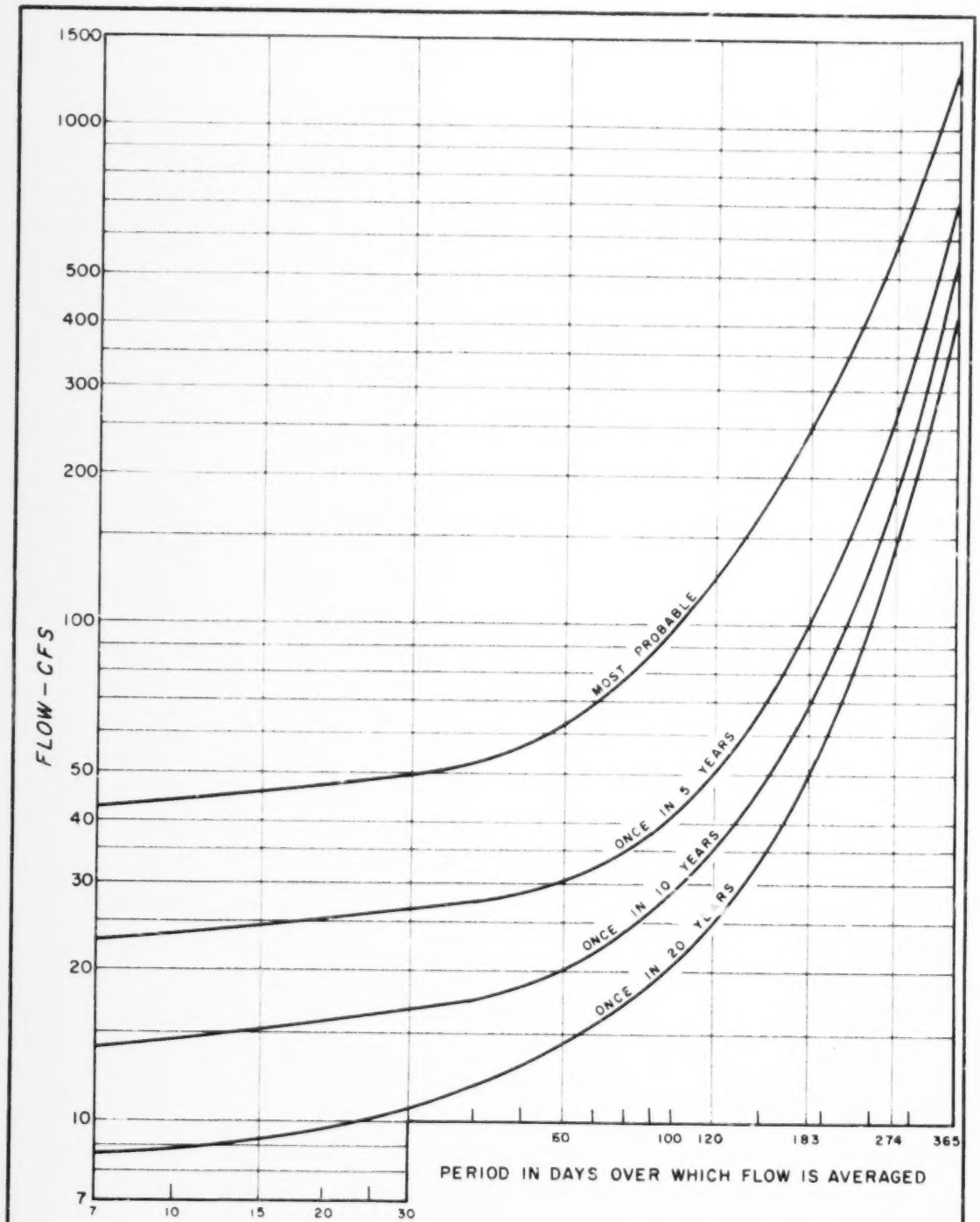

RECURRENCE INTERVAL IN YEARS
1.1
1.2
1.4
2.0
3.0
4.0
5.0
10.0
20.0
1200
1000
500
400
300
200
100
50
40
30
20
15
FLOW-CFS
PROBABILITY EQUAL TO OR LESS THAN
90
95
WATER RESOURCES STUDY
BUFFALO RIVER – ARKANSAS
FLOW FREQUENCY ANALYSIS
BUFFALO RIVER NEAR ST JOE, ARKANSAS
U.S DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII
DALLAS, TEXAS

FIGURE A – 5




WATER RESOURCES STUDY
BUFFALO RIVER – ARKANSAS

RELATION BETWEEN SEVERITY AND PERIOD OVER WHICH FLOW IS AVERAGED

BUFFALO RIVER NEAR ST. JOE, ARKANSAS

U.S. DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VII DALLAS, TEXAS

FIGURE A – 6